

ABSTRACT

A silicon single crystal rod (24) is pulled from a silicon melt (13) molten by a heater (17), and a change in diameter of the silicon single crystal rod every predetermined time is fed back to a pulling speed of the silicon single crystal rod and a temperature of the heater, thereby controlling a diameter of the silicon single crystal rod. A PID control in which a PID constant is changed on a plurality of stages is applied to a method which controls the pulling speed of the silicon single crystal rod so that the silicon single crystal rod has a target diameter and a method which controls a heater temperature so that the silicon single crystal rod has the target temperature.

A set pulling speed for the silicon single crystal rod is set so that V/G becomes constant, and an actual pulling speed is accurately controlled so as to match with the set pulling speed, thereby suppressing a fluctuation in diameter of the single crystal rod.

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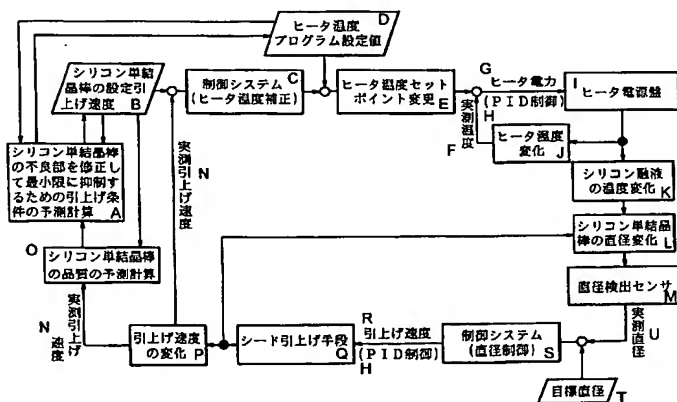
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(54) Title: METHOD OF PRODUCING SILICON MONOCRYSTAL

(54) 発明の名称: シリコン単結晶を製造する方法



- A...ESTIMATION CALCULATION OF PULL-OUT CONDITIONS TO MINIMIZE DEFECT OF SILICON MONOCRYSTAL ROD BY MODIFYING IT
B...PRESET PULL-OUT SPEED OF SILICON MONOCRYSTAL ROD
C...CONTROL SYSTEM (HEATER TEMPERATURE COMPENSATION)
D...HEATER TEMPERATURE PROGRAM PRESET VALUE
E...CHANGE OF HEATER TEMPERATURE SET POINT
F...MEASURED TEMPERATURE
G...HEATER ELECTRIC POWER
H...(PID CONTROL)
I...HEATER POWER SOURCE BOARD
J...HEATER TEMPERATURE VARIATION
K...VARIATION IN MELTED SILICON LIQUID TEMPERATURE
L...VARIATION IN SILICON MONOCRYSTAL ROD DIAMETER
M...DIAMETER DETECTION SENSOR
N...MEASURED PULL-OUT SPEED
O...ESTIMATION CALCULATION OF QUALITY OF SILICON MONOCRYSTAL ROD
P...VARIATION IN PULL-OUT SPEED
Q...SEED PULL-OUT MEANS
R...PULL-OUT SPEED
S...CONTROL SYSTEM (DIAMETER CONTROL)
T...AIMED DIAMETER
U...MEASURED DIAMETER

(57) Abstract: A silicon monocrystal rod (24) is pulled out from melted silicon liquid (13) melted by a heater (17), and variation in the diameter of the rod at pre-determined time intervals is fed back to a pull-up speed of the rod and to a heater temperature to control the diameter of the rod. PID control is applied to a method for controlling a pull-out speed of a silicon monocrystal rod so that the rod has an aimed diameter, and to a method for controlling a heater temperature so that the rod has an aimed diameter, and a PID constant is varied in plural steps in each of the methods. When a preset pull-out speed of a silicon monocrystal rod is set so that V/G is constant, and an actual pull-out speed is controlled with high accuracy so that the actual pull-out speed corresponds to the preset pull-out speed, the diameter of the silicon monocrystal rod is prevented from varying.

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